WHAT IS CLAIMED IS:

1. A perpendicular magnetic recording medium comprising a nonmagnetic substrate and layers laminated sequentially on the substrate, the layers including a nonmagnetic underlayer, a magnetic recording layer, a protective layer, and a liquid lubricant layer, wherein the magnetic recording layer is formed by alternately laminating an iron or cobalt layer having thickness in a range of 0.1 nm to 0.3 nm and a platinum layer having thickness in a range of 0.15 nm to 0.35 nm repetitively, and is mainly composed of an alloy of FePt or CoPt including a region of L10 type ordered lattice.

2. A perpendicular magnetic recording medium according to claim 1, wherein a thickness of the magnetic recording layer is in a range of 3 nm to 15 nm.

3. A perpendicular magnetic recording medium according to claim 1, wherein a (001) crystal lattice plane in the region of L10 type ordered lattice is formed in parallel to a surface of the magnetic recording layer.

4. A perpendicular magnetic recording medium according to claim 1, wherein the underlayer is composed of a metal being selected from a group consisting of Ag, Al, Au, Cu, Ir, Ni, Pt, and Pd, or an alloy mainly composed of at least one metal selected from the group consisting of Ag, Al, Au, Cu, Ir, Ni, Pt, and Pd, or the underlayer is composed of chromium or chromium alloy.

5. A perpendicular magnetic recording medium according to claim 1, wherein the underlayer has a thickness in a range of 5 nm to 50 nm.

6. A perpendicular magnetic recording medium according to claim 1 further comprising a nonmagnetic seed layer between the substrate and the underlayer, wherein the seed layer is composed of MgO, NiO, TiO, or titanium carbide or titanium nitride, and a dominant crystal alignment plane of the seed layer is (100) plane.

7. A perpendicular magnetic recording medium according to claim 6, wherein the seed layer has a thickness in a range of 3 nm to 15 nm.

8. A perpendicular magnetic recording medium according to claim 1, wherein the substrate is selected from a group consisting of an aluminum substrate, a silicon wafer with an oxidized surface, a fused quartz substrate, a glass substrate, and a plastic resin substrate.

9. A perpendicular magnetic recording medium according to claim 1, wherein perpendicular magnetic anisotropy energy Ku of the magnetic recording layer is in a range of 7×10^5 J/m^3 to 7×10^6 J/m^3.

10. A perpendicular magnetic recording medium according to claim 1, wherein the magnetic recording layer is formed by means of a DC magnetron sputtering method.

11. A method for manufacturing a perpendicular magnetic recording medium comprising:

preparing a nonmagnetic substrate;

forming a nonmagnetic underlayer on the substrate;

forming a magnetic recording layer mainly composed of an alloy comprising FePt or CoPt including a region of L10 type ordered lattice on the underlayer by laminating alternately an iron or cobalt layer having thickness in a range of 0.1 nm to 0.3 nm and a platinum layer having thickness in a range of 0.15 nm to 0.35 nm, repetitively; and

forming a protective layer on the magnetic recording layer, and forming a liquid lubricant layer on the protective layer.

12. A method for manufacturing a perpendicular magnetic recording medium according to claim 11, wherein the magnetic recording layer is formed by means of a DC magnetron sputtering method.

13. A method for manufacturing a perpendicular magnetic recording medium according to claim 11 further comprising a step of heating at a temperature lower or equal to 400°C after the step of forming the magnetic recording layer.

14. A method for manufacturing a perpendicular magnetic recording medium according to claim 11, wherein a temperature of the substrate in the step of forming the magnetic recording layer is lower or equal to 400°C.